IEC 60794-1-1

Edition 5.0 2023-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Optical fibre cables –
Part 1-1: Generic specification – General

Câbles à fibres optiques –
Partie 1-1: Spécification générique – Généralités

IEC 60794-1-1:2023-05(en-fr)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 33.180.10

ISBN 978-2-8322-6709-7

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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OPTICAL FIBRE CABLES –

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FOREWORD

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IEC 60794-1-1 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics. It is an International Standard.

This fifth edition cancels and replaces the fourth edition published in 2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) reorganization of the document to a more logical flow making it easier for the reader:
b) expansion of the tables to include names and definitions of all documents in the IEC 60794-x series;
c) expansion of the definitions, graphical symbols, terminology and abbreviations content, with the aim of making this document the default and reference for all others in the IEC 60794-x series;

d) inclusion of updated, reorganized and expanded optical fibre, attenuation and bandwidth subclauses, with the aim of making this document the default and reference for all others in the IEC 60794-x series.

The text of this International Standard is based on the following documents:

Draft	Report on voting
86A/2286/FDIS	86A/2313/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 60794 series, published under the general title *Optical fibre cables*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

OPTICAL FIBRE CABLES –

Part 1-1: Generic specification – General

1 Scope

This part of IEC 60794 applies to optical fibre cables for use with communication equipment and devices employing similar techniques. Electrical properties are specified for optical ground wire (OPGW) and optical phase conductor (OPPC) cables. Hybrid communication cables are specified in the IEC 62807 series.

The object of this document is to establish uniform generic requirements for the geometrical, transmission, material, mechanical, ageing (environmental exposure), climatic and electrical properties of optical fibre cables and cable elements, where appropriate.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60189-1, *Low-frequency cables and wires with PVC insulation and PVC sheath – Part 1: General test and measuring methods*

IEC 60304, *Standard colours for insulation for low-frequency cables and wires*

IEC 60793-1-21, *Optical fibres – Part 1-21: Measurement methods and test procedures – Coating geometry*

IEC 60793-1-22, *Optical fibres – Part 1-22: Measurement methods and test procedures – Length measurement*

IEC 60793-1-40, *Optical fibres – Part 1-40: Attenuation measurement methods*

IEC 60793-1-44, *Optical fibres – Part 1-44: Measurement methods and test procedures – Cut-off wavelength*

IEC 60793-1-46, *Optical fibres – Part 1-46: Measurement methods and test procedures – Monitoring of changes in optical transmittance*

IEC 60793-1-48, *Optical fibres – Part 1-48: Measurement methods and test procedures – Polarization mode dispersion*

IEC 60793-2, *Optical fibres – Part 2: Product specifications – General*

IEC 60793-2-10, *Optical fibres – Part 2-10: Product specifications – Sectional specification for category A1 multimode fibres*

IEC 60793-2-40:2021, *Optical fibres – Part 2-40: Product specifications – Sectional specification for category A4 multimode fibres*

IEC 60794-1-21, *Optical fibre cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical tests methods*

IEC 60794-1-22[1], *Optical fibre cables – Part 1-22: Generic specification – Basic optical cable test procedures – Environmental tests methods*

IEC 60811-201, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 201: General tests – Measurement of insulation thickness*

IEC 60811-202, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 202: General tests – Measurement of thickness of non-metallic sheath*

IEC 60811-203, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 203: General tests – Measurement of overall dimensions*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
no change in attenuation
acceptance criterion for attenuation measurement that includes an allowance for measurement uncertainty arising from measurement errors or calibration errors due to a lack of suitable reference standards

Note 1 to entry: For a practical interpretation, the following values shall be used:

a) No change in attenuation, single-mode (class B): the total uncertainty of measurement shall be ≤ ± 0,05 dB for the attenuation or ≤ ± 0,05 dB/km for the attenuation coefficient. Any measured value within this range shall be considered as “no change in attenuation”.

   The requirement for these parameters is indicated as “no change (≤ ± 0,05 dB or ≤ ± 0,05 dB/km)”.

   By agreement between customer and supplier, minor deviation from this limit may be accepted at some low frequency, for example less than 10 %. However, for mechanical tests no deviation in excess of 0,15 dB shall be accepted. For environmental tests no deviation in excess of 0,10 dB/km shall be accepted.

b) No change in attenuation, multimode (category A1): the total uncertainty of measurement shall be ≤ ± 0,2 dB for the attenuation or ≤ ± 0,2 dB/km for the attenuation coefficient.

   Any measured value within this range shall be considered as “no change in attenuation”.

   The requirement for these parameters is indicated as “no change (≤ ± 0,2 dB or ≤ ± 0,2 dB/km)”.

   By agreement between customer and supplier, minor deviation from this limit may be accepted at some low frequency, for example less than 10 %. However, for mechanical tests no deviation in excess of 0,5 dB shall be accepted. For environmental tests no deviation in excess of 0,5 dB/km shall be accepted.

c) No change in attenuation, plastic optical fibre (category A4): the total uncertainty of measurement for this document shall be ≤ 2 % of the maximum specified attenuation in IEC 60793-2-40:2021, Annex A to Annex I.

Any measured value within this range shall be considered as “no change in attenuation”.

[1] This document is progressively being replaced by the IEC 60794-1-2XX series.

3.2
allowable change in attenuation
<during mechanical and environmental tests> change in attenuation that may be a value larger than the no change limits, depending on fibre category, single-mode or multimode, cable design and application

3.3
link design attenuation
LDA
statistical upper bound for the attenuation coefficient of the concatenated optical fibre cables

3.4
no change in fibre strain
acceptance criterion for fibre strain measurement that includes an allowance for measurement uncertainty arising from measurement errors or calibration errors due to a lack of suitable reference standards

Note 1 to entry: For a practical interpretation, the total uncertainty of measurement shall be ± 0,05 % strain. Any measured value within this range shall be considered as “no change in strain”.

3.5
allowable change in fibre strain
<during mechanical and environmental tests> level of strain that will not compromise fibre mechanical reliability for some of the parameters specified

3.6
circuit integrity
ability of the cable under test to continue to operate in a designated manner whilst subjected to a specified flame source for a specified period of time

3.7
fire resistance
ability of the cable under test to resist functional failure to operate in a designated manner whilst subjected to a specified flame source for a specified period of time

3.8
shrinkage
irreversible contraction after extrusion of plastic materials caused by heating or over time at ambient temperature

3.9
cable load definitions (non-aerial applications)

3.9.1
long-term load
T_L
acceptable amount of long-term load which the cable can experience during operation (i.e. after installation is completed)

Note 1 to entry: Long-term load can be due either to residual loading from the installation process or environmental effect, or both. This is the rated maximum load for which a cable is subject to in long term tests.

Note 2 to entry: For 1 % proof-tested fibres, the fibre strain under long term tensile load (T_L) shall not exceed 20 % of this fibre proof strain (equal to absolute 0,2 % strain) and there shall be no change in attenuation during the test.

Note 3 to entry: For fibres proof tested at higher levels the safe long-term load will not scale linearly with the proof strain, so a lower percentage of the proof strain is applicable. For proof-tested fibres at levels higher than 1 % and up to 2 %, the strain at T_L shall be limited to 17 % of the proof-test strain (equal to absolute 0,34 % strain for 2 % proof tested fibres).

3.9.2
short-term load
T_S
acceptable amount of short-term load that can be applied to a cable without permanent degradation of the characteristics of the fibres, cable elements or sheath

Note 1 to entry: Short-term load is often called rated installation load.

Note 2 to entry: Under short term tensile load (T_S) the fibre strain shall not exceed 60 % of the proof strain (equal to absolute 0,6 % strain for 1 % proof-tested fibres) and the attenuation change during test shall be measured and recorded.

3.10
cable load definitions and tensile testing terminology (self-supporting aerial applications)

3.10.1
maximum allowable tension
MAT
maximum tensile load that can be applied to the cable without detriment to the performance requirements (e.g. attenuation, fibre reliability) due to fibre strain

Note 1 to entry: Due to installation codes the MAT value is sometimes restricted to be less than 60 % of the breaking tension of the cable.

Note 2 to entry: This is also called ultimate operational strength (UOS), equal to 60 % of RTS (and fibre strain < 0,35 %, 1/3 of proof test). MAT < 60 % UOS.

Note 3 to entry: This is also called every day stress (EDS), defined as 25 % of RTS and no fibre strain (< 0,05 %) and no attenuation increase (< 0,05 dB).

3.10.2
strain margin
value of cable elongation at the onset of fibre strain

Note 1 to entry: The strain margin can also be expressed as cable load (N) at the onset of the fibre strain.

3.10.3
breaking tension
tensile load that will produce physical rupture of the cable

Note 1 to entry: The breaking tension can be calculated, provided that the design model has been validated.

3.10.4
maximum installation tension
MIT
maximum recommended stringing tension during installation

3.10.5
rated tensile strength
RTS
summation of the product of nominal cross-sectional area, nominal tensile strength, and stranding factor for each load bearing material in the cable construction

3.11
cable section
individual reel of cable, as produced

3.12
cable element
component of a cable designed to house and protect the optical fibres

Note 1 to entry: This was changed from “fibre optic unit” in IEC 60794-4-10 to “cable element” to be consistent with IEC 60794-1-23 and also to avoid confusion with IEC 60794-5-20.

Note 2 to entry: The cable sheath is included as a cable element.

3.13
polarization mode dispersion (PMD) terms

3.13.1
differential group delay
DGD
relative time delay between the two fundamental polarization modes (principal states of polarization) at the end of an optical fibre cable, at a particular time and wavelength

Note 1 to entry: Differential group delay is expressed in ps.

3.13.2
polarization mode dispersion value
PMD value
average of DGD values across wavelengths

Note 1 to entry: The polarization mode dispersion value is expressed in ps.

3.13.3
polarization mode dispersion coefficient
PMD coefficient
PMD value of an optical fibre cable divided by the square root sum of its length (km)

Note 1 to entry: The polarization mode dispersion coefficient is expressed in ps/√km.

3.13.4
link
length of cable composed of a number of individual cable sections

Note 1 to entry: Link PMD values are generally calculated in accordance with the formulae given in IEC TR 61282-3 but may be measured.

3.14
terminated cable assembly
cable terminated with connectors

Note 1 to entry: A patch cord or jumper is one type of a terminated cable assembly.

Note 2 to entry: The following terms for terminated cable assemblies with connector(s) at both ends are used in the ISO/IEC 11801 series: patch cords, work area cords and equipment cords.

3.15
aerial cable types

3.15.1
all dielectric self-supporting
ADSS
cable that is capable of enduring aerial installation and providing long term service, without any external tensile support

3.15.2
optical attached cable
OPAC
dielectric cable that is not self-supported, but attached to an electrical earth wire or phase conductor, using one of the following attachment methods: wrapped, lashed or preform attached

3.15.3
wrapped
lightweight flexible non-metallic (“wrap”) cable that can be wrapped helically around either the earth wire or the phase conductor using special machinery

3.15.4
lashed
non-metallic cables that are installed longitudinally alongside the earth wire, the phase conductor or on a separate support cable (on a pole route) and are held in position with a binder or adhesive cord

3.15.5
preform attached
cable similar to the lashed cables but attached with the use of special preformed spiral attachment clips

3.15.6
optical ground wire
OPGW
metallic optical cable for overhead power lines that has the dual performance functions of a conventional ground wire with telecommunication capabilities

3.15.7
optical phase conductor
OPPC
Metallic hybrid optical cable that has the dual performance functions of a conventional phase conductor with telecommunication capabilities

3.16
composite cable
optical fibre cable containing more than one fibre category

3.17
hybrid communication cable
cable that contains more than one media type, including but not limited to optical fibres, twisted pair/quad cables, or coaxial cables or all of them

3.18
rounding error
rule[2] of “rounding half away from zero” when the results recorded display more than the significant number of digits required in the acceptance criteria.

Note 1 to entry: Only the first digit beyond the number of significant digits is used in determining the rounding.

EXAMPLE 1: Against a requirement of 0,22 dB/km maximum attenuation, values up to 0,224 dB/km conform, whilst values of 0,225 dB/km and above are failures.

EXAMPLE 2: Against a requirement of ± 0,05 dB, values between -0,054 and +0,054 are deemed acceptable.

3.19
maximum allowable ovality
largest permissible ovality of the optical unit or its component calculated as:

$2 \times (d1 - d2) / (d1 + d2)$ in % where:

$d1$ is the maximum measured diameter of the cable or the component

$d2$ is the minimum diameter of the cable or the component at the same cross-section as $d1$

[2] Please see ISO/IEC Guide 98-3:2008, Clause 7, on uncertainty of measurement for additional information.

3.20
breakout cable
cable consisting of subunits which can be separate fibre optical cables surrounded by a sheath of suitable material

Note 1 to entry: In the application this outer sheath of the breakout cable can be removed over a certain length and the subunits can be used as separate fibre optic cables.

4 Graphical symbols and abbreviated terms

For the purposes of this document, the abbreviated terms given in IEC TR 61931 as well as the following apply.

ADSS	all dielectric self-supporting
APL	aluminium/polyethylene laminate
ΔD	minimum wall thickness of a microduct
ΔD'	minimum thickness of the outer sheath of a protected microduct
D	nominal outer diameter of a microduct cable
d	nominal outer diameter of a cable (including microduct fibre units)
dc	nominal outer diameter of a conduit or subduct
DS	detail specification
EDS	every day stress
ID	nominal inner diameter of a microduct
I/O-port	input/output port for launching OF cables into and out of a pipe
λ_{CC}	cable cut-off wavelength
$\lambda_{operational}$	operational wavelength
LDA	link design attenuation
m	mass of 1 km of cable (in the context of tensile testing)
MAOC	maximum allowable ovality of cable
MAT	maximum allowable tension
MASS	metallic aerial self-supported cables
MICE	mechanical, ingress, climatic, or electromagnetic
MIT	maximum installation tension
$n \times d$	product of a variable and the cable outer diameter used for determining appropriate sizes for bends, mandrels, etc.
$n \times OD$	product of a variable and the outer diameter of a microduct used for determining appropriate sizes for bends, mandrels, etc.
$n \times OD$'	product of a variable and the outer diameter of a protected microduct used for determining appropriate sizes for bends, mandrels, etc.
OCEPL	optical cable to be used along electrical power lines
OD	nominal outer diameter of a microduct
OD'	nominal outer diameter of a protected microduct
OPAC	optical attached cable (or optical power attached cable)
OPGW	optical ground wire
OPPC	optical phase conductor
PE	polyethylene
RTS	rated tensile strength